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**$\mu$–PIV/Shadowgraphy measurements to elucidate dynamic physicochemical interactions in a multiphase model of pulmonary airway reopening**[1]

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We employ micro-particle image velocimetry ($\mu$-PIV) and shadowgraphy to measure the ensemble-averaged fluid-phase velocity field and interfacial geometry during pulsatile bubble propagation that includes a reverse-flow phase under influence of exogenous lung surfactant (Infasurf). Disease states such as respiratory distress syndrome (RDS) are characterized by insufficient pulmonary surfactant concentrations that enhance airway occlusion and collapse. Subsequent airway reopening, driven by mechanical ventilation, may generate damaging stresses that cause ventilator-induced lung injury (VILI). It is hypothesized that reverse flow may enhance surfactant uptake and protect the lung from VILI. The microscale observations conducted in this study will provide us with a significant understanding of dynamic physicochemical interactions that can be manipulated to reduce the magnitude of this damaging mechanical stimulus during airway reopening. Bubble propagation through a liquid-occluded fused glass capillary tube is controlled by linear-motor-driven syringe pumps that provide mean and sinusoidal velocity components. A translating microscope stage mechanically subtracts the mean velocity of the bubble tip in order to hold the progressing bubble tip in the microscope field of view. To optimize the signal-to-noise ratio near the bubble tip, $\mu$-PIV and shadow images are recorded in separate trials then combined during post-processing with help of a custom-designed micro scale marker. Non-specific binding of Infasurf proteins to the channel wall is controlled by oxidation and chemical treatment of the glass surface. The colloidal stability and dynamic/static surface properties of the Infasurf-PIV particle solution are carefully adjusted based on Langmuir trough measurements. The Finite Time Lyapunov Exponent (FTLE) is computed to provide a Lagrangian perspective for comparison with our boundary element predictions.

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